Columbus HTS Power Cable

Project Fact Sheet

This project involves field-testing of a long-length HTS cable under real environmental stresses and real electrical loads. The cable system will form an important electrical link in a utility substation in Columbus, Ohio, replacing conventional cables with limited current-carrying capacity.

What are its Primary Applications?

HTS power cables are used for electricity transmission and distribution. The Columbus cable is a distribution cable, conducting electricity within a local grid.

What are the Benefits to Utilities?

HTS cable, carrying three to five times more power than conventional cable, can meet increasing power demands in urban areas via retrofit applications, eliminating the need to acquire new rights-of-way. The new cable design incorporated in this project has the potential to further reduce space requirements by running all three phases of a power line through a single cable. Power transmission in underground HTS cables can substitute for overhead transmission lines when environmental and other concerns prohibit overhead installation. Exceptionally low losses made possible by HTS cable will enhance overall system efficiency, increase flexibility, and reduce electricity costs.

What is the Market Potential?

As energy demands increase and environmental concerns heighten, underground HTS cable will provide the necessary alternative to meet power supply needs. The development of commercially viable HTS transmission cable will allow U.S. industry to capture a large portion of the growing national market. In addition, international markets are estimated to be 10 times larger than the U.S. market, and growing more rapidly.

Superconducting cables have the potential to create an efficient "electricity superhighway," much like the advent of fiber optic cable has aided the development of the "information superhighway."

What are the Project Accomplishments to Date?

ULTERA was created as a partnership between U.S. cable manufacturer Southwire and nkt cables of Germany, formed to continue the development and eventual commercialization of HTS cables.

A five meter section of triaxial cable being inserted into the cryostat for laboratory testing.

The 200 meter cable project was awarded in late 2002. ULTERA will share the cost of the project with the U.S. Department of Energy. Project scientists, along with Oak Ridge National Laboratory (ORNL), have already performed extensive research on a new "tri-axial" cable design, and one and five-meter cables have been fabricated and tested. Research involving cable terminations, a challenging issue with a tri-axial cable, and bend-testing of the cables continues.

The demonstration cable is expected to begin operation in a utility substation by early 2006, and will serve a large section of the city of Columbus, Ohio, including both residential and industrial customers. The cable is being designed to operate at 13.2 kV and carry up to 3,000 amps. Half of the length of the cable will be run above ground, while the other half will be run through conduit below grade to simulate a common cable application.

What is the Status of the Project?

The project was awarded in 2002. ULTERA and ORNL have undertaken extensive testing on the triaxial cable design, using a 5-meter prototype for termination design and testing. A 100-foot HTS cable developed in an earlier Southwire/DOE partnership continues to supply reliable power to three Southwire manufacturing plants.

Office of Electric Transmission and Distribution, TD-1
U.S. Department of Energy – 1000 Independence Avenue, SW – Washington, DC 20585.

Goal:

Complete the development, installation, and testing of a 200 meter, 3-phase high-temperature superconducting (HTS) power cable at a substation in Columbus, Ohio. The project will demonstrate how a triaxial HTS cable may be used in the future to replace existing oil-filled underground copper cables and greatly increase the capacity of a power link.

Team:

ULTERA (team leader)

American Electric Power (host utility)

Oak Ridge National Laboratory (supporting technology and research)

Integrations Concepts Enterprises (power controls)

Period of Performance:

4/2002-7/2006

Cumulative Project Funding:

Private $4.32 million (50%)
DOE $4.32 million (50%)
Total: $8.65 million

What is it?

A power cable is designed to carry large amounts of electrical current over short or long distances.

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The result of an earlier public-private partnership, Southwire's HTS cables have delivered 1,250 A to a manufacturing plant for over 25,000 hours.

The project builds on an earlier, very successful partnership between Southwire and DOE in which three 100-foot long cables were constructed and installed above ground in Carrollton, Georgia. These cables exceeded design goals by over 100 percent, and began delivering power to three Southwire manufacturing plants on February 18, 2000. That system has been in continuous operation and has run unsupervised at 100 percent load for over 25,000 hours. Recent analysis of the system showed no significant degradation in the conductivity of the HTS wire over that time. In addition to incorporating a new design, the new project will carry about twice the current of the earlier pilot project.

How Does it Work?

Conventional conductors of copper or aluminum are replaced by HTS wire, enabling the cable to carry greater amounts of current with fewer losses due to resistance.

Alignment with Administration Priorities:

National Energy Policy: " …expand the Department's research and development on transmission reliability and superconductivity"

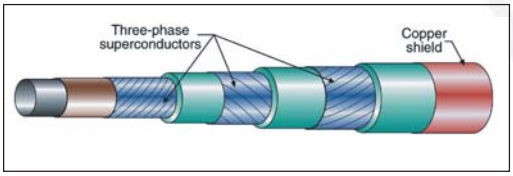
National Transmission Grid Study: " … accelerate development and demonstration of its technologies, including high-temperature superconductivity…

Secretary of Energy: "… focuses R&D dollars on long-term, potentially high-payoff activities that require Federal involvement to be both successful and achieve public benefit."

Energy Information Administration: "Of [advanced power delivery] technologies, superconductivity holds the most promise for yielding significant efficiency gains."

The cable requires a cooling system to refrigerate the HTS conductors to a temperature at which resistance is minimized, about 321 degrees Fahrenheit below zero.

To further reduce costs and alternating current (AC) losses in the 3-phase power line, Southwire has been investigating the "tri-axial" design for a power cable. In this scheme, rather than having three independent HTS cables comprising the three phases, a single cable is constructed with three electrically insulated layers of superconductor built around the same axis. Southwire believes the new design will reduce the cooling load of the system, and having concentric phases will also lead to reduced electro-magnetic fields. In addition, the new design will require only about half of the superconducting materials required by the earlier design and will take up less space, since a single cable will perform the job of what previously required three separate cables.



Graphical depiction of the triaxial cable design.

Like its predecessor, the cable will be a "cryogenic dielectric" cable design in which a central former is wrapped with three HTS layers of tape and electrical insulation. The entire assembly is then insulated and jacketed to protect it from thermal and physical damage. The cable is cooled by passing liquid nitrogen through the hollow central former along the length of the cable, which is then returned through gaps in an outer layer of the cable assembly.

The cable is expected to lose only about a half of a percent of the power it transmits, compared to the 5–8 percent lost by traditional power cables.